Maine Agricultural Experiment Station

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EXPERIMENTS WITH POTATOES.

This Bulletin contains the analyses of samples of Potatoes from sprayed and unsprayed fields, with reference to the effect of spraying upon starch content; the ash analysis of potatoes; and a discussion of fertilizers needed for potatoes.

Requests for the Bulletins should be addressed to the
AGRICULTURAL EXPERIMENT STATION,
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EXPERIMENTS WITH POTATOES.

CHAS. D. WOODS AND J. M. BARTLETT.

An investigation was planned for the purpose of determining the effect of spraying potato vines with Bordeaux mixture on the starch content of the tubers. As starch accumulates most rapidly when the plant is maturing, it seemed reasonable to assume that if spraying prevented blight and prolonged the life of the plant to its natural period of growth, the tubers would be of better quality with a larger proportion of starch than those from immature plants. Aroostook county being the great potato county of the State, where large starch factories are located, arrangements were made in the fall of 1898, with growers in that section to supply us with potatoes from sprayed and unsprayed fields.

The samples were selected by the growers and only merchantable potatoes were taken for analysis. About the time that we were preparing to begin the analyses, Dr. Wiley, Chief Chemist of the U. S. Department of Agriculture, visited the State to study the starch factories of Aroostook. He kindly offered to have the analyses of the potatoes made in his laboratory, and the samples were accordingly forwarded to Washington. The Department laboratory was being entirely rebuilt at that time and this occasioned so much delay in the analyses that the results were not received until the growing season was well begun and it was, therefore, deemed best to defer the publication until the present time.

The description of the samples and the results of the analyses as found by the Chemical Division of the U. S. Department of Agriculture follow:

DESCRIPTION OF POTATO SAMPLES.

No. 3036, *Beauty of Hebron.* Grown by C. H. Richardson, Fort Fairfield; sample was taken from a field of eight acres which had been in pasture since being cleared until 1896. In 1896 it bore a heavy crop of potatoes without any rust; in 1897, it was again planted to pota-

toes with a light yield and an early rust. The yield in 1896 was about 100 barrels per acre and in 1897 about 50 barrels. The soil is light red loam and, like most land in that vicinity, is on a shell-like lime rock ledge. The field was plowed in the fall of 1897, and harrowed three times in the spring with a spring toothed harrow. It was planted with a planter and hoed with a horse hoe. The field had received no manure until in 1896 and that year, and in 1897 and in 1898 it received about 500 pounds of complete fertilizer per acre. In 1898, the crop was planted May 19 and harvested between September 1 and 20.

The crop was sprayed twice with Bordeaux mixture, July 30 and August 9, but it was too late to save the plants from the blight. The yield was about fifty barrels of merchantable potatoes and fifteen barrels of small ones, per acre.

No. 3037, *Beauty of Hebron.* These potatoes were taken from a field adjoining that from which No. 3036 were taken. The field was plowed for the first time in the fall of 1897 and the crop was grown on the sod without the addition of any fertilizing materials.

Nos. 3038 *and* 3039, *White Elephant and* 3040 *and* 3041, *Delaware.* These samples were from T. B. Bradford, Golden Ridge, Sherman, Maine. The land had a slope to the north; had been in grass until October, 1897, when it was plowed. The soil was dark soil, inclined to be wet, and was not underdrained. The sub-soil was gravelly. It received about ten two-horse loads of barn manure, broadcast, over the field and about 500 pounds of fertilizer per acre; the fertilizer was applied in the drill. The field was planted June 1 and harvested September 28. The whole field was sprayed three times with Bordeaux mixture by the use of an Aspinwall Sprayer; in addition to this, sample No. 3038 was sprayed more with a knapsack sprayer. At the time that had been sprayed five times, the others were killed by rust. There were forty-five barrels of merchantable potatoes and seventy-five barrels of small potatoes per acre. All of the potatoes rotted very badly, and the decay began before any of the leaves were killed.

Nos. 3044 *and* 3045, *White Elephant.* These samples were received without the name of the sender. Three thousand forty-four was not sprayed and 3045 was sprayed with Bordeaux mixture.

Nos. 3046 *and* 3047, *White Elephant.* These were grown by R. S. Hoyt of Fort Fairfield. The field has a slope to the northeast and was in pasture previous to 1896. In 1897, a crop of potatoes was grown with the addition of 300 pounds of fertilizer. The yield was about sixty barrels. The field was plowed again in October, 1897, harrowed May 20, 1898, planted May 24 and harvested September 21. Four hundred pounds of complete fertilizer were used, applied in the drill. The part from which No. 3046 was taken, was sprayed twice, and 3047 was not sprayed. The yield was sixty-five barrels of merchantable potatoes and twenty-five barrels of small potatoes per acre.

Nos. 3050 *and* 3051, *White Elephant.* Grown by Powers Bros. of Caribou. The field bore potatoes in 1895; was seeded to oats in 1896 and grew a crop of red clover in 1897. The soil is a medium light clay loam with a gravelly sub-soil. The field was plowed in October, 1897,

and harrowed in the spring. Four hundred pounds commercial fertilizer was applied in the drill, and the piece was planted May 15-19 and harvested September 20-25. The field was sprayed three times but finally succumbed to the blight. The yield was sixty barrels of merchantable potatoes and thirteen barrels of small ones per acre. Number 3051 was from an unsprayed portion of the field.

Nos. 3052 *and* 3053, *Delawares.* The name of the sender and the culture is not known, except that 3052 was sprayed with Bordeaux mixture and 3053 was unsprayed.

Nos. 3054 *and* 3055, *Carmen.* These were from the same person as 3052 and 3053. No. 3054 was sprayed with Bordeaux mixture and 3055 was unsprayed.

ANALYSIS OF POTATOES GROWN IN 1898, THE RESULTS CALCULATED TO WATER CONTENT AT TIME OF SAMPLING.*

Variety.	Laboratory No.	Water.	Starch.	Fiber.	Protein nitrogen X 6.25.	Ash.	Total.	Specific gravity.
		%	%	%	%	%	%	
Hebron	3036	79.72	16.94	0.90	2.12	0.76	100.44	1.0604
Hebron	3037	78.13	18.59	0.72	2.06	0.78	100.28	1.0795
White Elephant	3038	76.81	19.96	0.84	2.19	0.99	100.79	1.0867
White Elephant	3039	76.92	20.38	0.90	2.31	0.87	101.38	1.0742
White Elephant	3044	78.74	15.96	0.64	2.25	0.92	98.51	1.0803
White Elephant	3045	75.21	19.31	0.61	2.12	0.83	98.02	1.1058
White Elephant	3046	75.88	18.81	0.56	2.25	0.96	98.46	1.0921
White Elephant	3047	77.44	18.12	0.63	2.06	0.88	99.13	1.0906
White Elephant	3050	75.56	18.14	0.56	1.81	1.04	97.11	1.1129
White Elephant	3051	78.13	18.62	0.63	1.75	0.98	100.11	1.0881
Delaware	3040	76.02	19.20	0.61	2.06	1.01	98.90	1.0852
Delaware	3041	76.93	18.63	0.61	2.19	0.94	99.30	1.0904
Delaware	3052	75.72	18.63	0.55	2.31	0.95	98.16	1.0745
Delaware	3053	77.64	16.26	0.61	2.56	0.91	97.98	1.1120
Carmen	3054	76.87	18.03	0.66	2.06	0.90	98.52	1.0967
Carmen	3055	76.57	17.07	0.59	2.38	0.76	97.37	1.0804

*The analyses were made by the Chemical Division of the U. S. Department of Agriculture.

As these results are not given in the usual form of food analyses, they are presented in that form on both the fresh and water free basis in the tables which follow. As the fat was not determined, it is included with the carbohydrates. It will be

seen that the starch as determined, as given in the table on page 147, exceeds in several instances, the combined carbohydrates and fat, as given on page 149. These discrepancies are due to the fact that the analytical methods have in several cases given too high results, carrying the total above 100 per cent, while in the second table, the carbohydrates and fat are calculated by difference. The average of 136 analyses, as compiled in Bulletin 28 of the Office of Experiment Stations of the United States Department of Agriculture, is added for comparison:

ANALYSES OF POTATOES.

RESULTS CALCULATED TO WATER-FREE BASIS.

Variety.	Laboratory number.	Ash.	Protein.	Fiber.	Carbohyd. rates and fat.
		%	%	%	%
Hebron	3036	3.75	10.45	4.44	81.36
Hebron	3037	3.57	9.42	3.29	83.72
Average	.....	3.66	9.94	3.86	82.54
White Elephant	3038	4.27	9.44	3.62	82.67
White Elephant	3039	3.77	10.01	3.90	82.32
White Elephant	3044	4.33	10.58	3.01	82.08
White Elephant	3045	3.35	8.55	2.46	85.64
White Elephant	3046	3.98	9.33	2.32	84.37
White Elephant	3047	3.90	9.13	2.79	84.18
White Elephant	3050	4.26	7.41	2.29	86.04
White Elephant	3051	4.48	8.00	2.88	84.64
Average	.....	4.04	9.06	2.91	83.99
Delaware	3040	4.21	8.59	2.54	84.66
Delaware	3041	4.07	9.49	2.65	83.79
Delaware	3052	3.91	9.51	2.27	84.31
Delaware	3053	4.07	11.45	2.73	81.75
Average	.....	4.06	9.76	2.55	83.63
Carmen	3054	3.89	8.91	2.85	84.35
Carmen	3055	3.24	10.16	2.52	84.08
Average	.....	3.57	9.53	2.69	84.21
Average of 136 samples*	.....	4.61	10.14	1.84	83.41

* Bulletin 28 of the Office of Experiment Stations.

ANALYSES OF POTATOES.

RESULTS CALCULATED TO WATER CONTENT AT TIME OF SAMPLING.

Variety.	Laboratory No.	Water.	Ash.	Protein.	Fiber.	Carbohydrates and fat.
		%	%	%	%	%
Hebron	3036	79.72	.76	2.12	.90	16.50
Hebron	3037	78.13	.78	2.06	.72	18.31
Average		78.92	.77	2.09	.81	17.41
White Elephant	3038	76.81	.99	2.19	.84	19.17
White Elephant	3039	76.92	.87	2.31	.90	19.00
White Elephant	3044	78.74	.92	2.25	.64	17.45
White Elephant	3045	75.21	.83	2.12	.61	21.23
White Elephant	3046	75.88	.96	2.25	.56	20.35
White Elephant	3047	77.44	.88	2.06	.63	18.99
White Elephant	3050	75.56	1.04	1.81	.56	21.03
White Elephant	3051	78.13	.98	1.75	.63	18.51
Average		76.84	.93	2.09	.67	19.47
Delaware	3040	76.02	1.01	2.06	.61	20.30
Delaware	3041	76.93	.94	2.19	.61	19.33
Delaware	3052	75.72	.95	2.31	.55	20.47
Delaware	3053	77.64	.91	2.56	.61	18.28
Average		76.58	.95	2.28	.60	19.59
Carmen	3054	76.87	.90	2.06	.66	19.51
Carmen	3055	76.57	.76	2.38	.59	19.70
Average		76.72	.83	2.22	.63	19.60
Average of 136 analyses*		78.30	1.00	2.20	.40	18.10

* Bulletin 28 of the Office of Experiment Stations.

ANALYSES OF THE ASH OF POTATOES.

In four samples large quantities of the ash were obtained for analysis. These analyses were also made by the Chemical Division of the United States Department of Agriculture. The results follow:

PERCENTAGES OF IMPURITIES (CARBON, SAND AND SILICA) AND PURE ASH IN THE CRUDE ASH.

Sample number.	Impurities.	Pure Ash.
	%	%
3045	9.36	90.64
3047	12.32	87.68
3050	5.14	94.86
3051	7.04	92.96

ANALYSIS OF PURE ASH OF POTATOES.

Sample number.	Potash, K_2O.	Soda, Na_2O.	Lime, CaO.	Magnesia, MgO.	Phosphoric acid, P_2O_5.	Sulphuric acid, SO_3.
	%	%	%	%	%	%
3045	55.13	1.70	1.01	3.85	15.78	6.92
3047	56.16	1.62	1.38	3.93	14.50	5.98
3050	56.43	1.70	1.29	3.76	15.00	6.38
3051	57.30	2.15	1.05	3.57	13.33	5.56

RELATION BETWEEN STARCH CONTENT AND SPECIFIC GRAVITY.

The specific gravity of starch is 1.65, water being taken as one. From this it would seem to follow that the richer a potato is in starch, the higher will be its specific gravity. From this assumption, a German agricultural calendar* has for years published a table giving the starch content of potatoes corresponding to various specific gravities. Assuming this method to be reliable, one of the best experiment stations in the United States has made an otherwise valuable investigation of little account. In Wiley's Principles and Practice of Agricultural Analysis, the unreliability of this method for scientific purposes is pointed out. The figures obtained in the analyses here reported, show in a striking manner the unreliability of the specific gravity method of determining starch in potatoes. In only one instance, (No. 3045) is there a practical agreement between the starch deter-

*Mentzel und v. Lengerke's Landw. Huelfs und Schreib-Kalender.

mined chemically and that found by the specific gravity method. Number 3036 has the lowest specific gravity of any of the samples examined, and 3053 has the next to the highest. Number 3036 carries 16.94 per cent while 3053 has only 16.26 per cent. As found by specific gravity, 3036 would have only ten per cent of starch and 3053 would have over twenty per cent. In the table which follows the samples are arranged according to their specific gravities.

TABLE SHOWING ABSENCE OF RELATION BETWEEN SPECIFIC GRAVITY AND STARCH CONTENT OF POTATOES.

Sample number.	Specific gravity.	Starch by specific gravity.	Starch directly determined.
		%	%.
3036	1.0604	10.1	16.94
3039	1.0742	12.7	20.38
3052	1.0745	12.9	18.63
3037	1.0795	13.8	18.59
3044	1.0803	13.9	15.96
3055	1.0804	13.9	17.07
3040	1.0852	15.0	19.20
3038	1.0867	15.3	19.96
3051	1.0881	15.6	18.62
3041	1.0904	16.1	18.63
3047	1.0906	16.2	18.12
3046	1.0921	16.4	18.81
3054	1.0967	17.5	18.03
3045	1.1058	19.4	19.31
3053	1.1120	20.7	16.26
3050	1.1129	20.9	18.14

EFFECT OF SPRAYING UPON THE STARCH CONTENT OF POTATOES.

As before stated, this investigation was begun with the express purpose of studying the effect of spraying upon the starch content of the potatoes. Owing to the fact that in most instances the spraying was begun so late that none of the potatoes here sampled completely escaped the attack of the blight, it was thought that very little, if any, difference would be found

between the starch content of potatoes whose vines were sprayed with Bordeaux mixture and those unsprayed. Theoretically, anything which prolongs the growing season ought to increase the amount of starch which will be stored up in the potato; hence, if vines sprayed with Bordeaux mixture live longer than those not treated, not only should the yield of potatoes be larger, but the percentage of starch should be higher.

PERCENTAGES OF STARCH IN SPRAYED AND UNSPRAYED POTATOES.

Variety of potatoes.	Sprayed.		Unsprayed.	
	Sample No.	Starch.	Sample No.	Starch.
		%		%
White Elephant	3038	19.96	.....	.....
	3039	20.38	.....	.....
	3045	19.31	3044	15.96
	3046	18.81	3047	18.12
	3050	18.14	3051	18.62
Average	.....	19.32	.....	17.52
Delaware	3040	19.20	3041	18.63
	3052	18.63	3053	16.26
Average	.....	18.92	.....	17.45
Carmen No. 1	3054	18.03	3055	17.07
Average of all	.....	19.06	.....	17.43

In the case of the Hebron potatoes, the unsprayed had a larger starch content than the sprayed. From the description of the samples, it will be noted that the field from which the sprayed potatoes were taken had been planted to this crop for three years, while the unsprayed was on sod, and that the growing time of the plants was not prolonged by the spraying. In the other instances, spraying seemed to increase the percentage of starch in the tubers. The four samples of White Elephant potatoes which had been sprayed, contained 19.3 per cent of starch, while the three samples of the same variety unsprayed had on the average only 17.5 per cent. The two samples of sprayed Delawares had 18.9 per cent and the unsprayed 17.4 per cent of starch, and the one sample of sprayed Carmen had 18.0 per cent against 17.1 per cent for the unsprayed. So far

as these cases go, they seem to indicate that spraying with Bordeaux mixture not only prolonged the life of the vines, but that sprayed potatoes contained higher percentages of starch than unsprayed.

The results of a single experiment at Kalmaes Agricultural College, Norway, gave results indicating a very beneficial influence from Bordeaux mixture, both in yield and in starch content of the potatoes grown. The condensed results were as follows:*

	Yield per acre.	Starch content.
	Lbs.	%
Potatoes not treated with Bordeaux mixture	1,426	13.9
Potatoes treated once with Bordeaux mixture	2,116	14.3
Potatoes treated twice with Bordeaux mixture	2,858	16.3

THE STARCH CONTENT OF AROOSTOOK GROWN POTATOES COMPARED WITH THAT OF POTATOES GROWN ELSEWHERE.

The sixteen samples here reported upon were found to carry an average of 18.29 per cent of starch. The percentages ranged from 15.96 to 20.38 per cent. Two of the samples carried about 16 per cent, two about 17, two about 19 and two about 20 per cent. The other samples had about 18 per cent. The eight sprayed samples had an average of 19.06 per cent and the unsprayed had an average of 17.43 per cent of starch. It is probable that the crop of 1898 did not average much above that of the unsprayed samples here reported upon.

In 1890, the Utah Experiment Station† made sixteen analyses of potatoes in which the starch ran abnormally high. In 1894 and 1895, the same station made about seventy-five analyses in which the starch content varied from a minimum of 10.17 per cent to a maximum of 22.49, with an average of about 17 per cent.

The analyses of something over 200 samples of potatoes by the West Virginia Experiment Station‡ show a range in starch from 13.46 per cent to 21.43 per cent. Only four of the samples

* Experiment Station Record, Vol. 8, p. 122.
† Report of Utah Experiment Station for 1896, pp. 21 to 25.
‡ Report of West Virginia Experiment Station, 1896, pp. 50-57.

contained twenty per cent or above of starch and fourteen had less than fifteen per cent. The greater number of the samples carried between 15.50 and 17.50 per cent. The average was 16.50 per cent.

In fifteen samples of Norwegian grown potatoes,* the starch ranged from 12.3 to 20.3 per cent with an average of 14.91 per cent. In still another lot of Norwegian potatoes† consisting of 122 samples, 20 samples contained less than 13.19 per cent of starch, 22 samples contained less than 14.15 per cent, 38 samples contained less than 15.06 per cent of starch and 42 samples had over 17 per cent. The highest percentage found was 20.59 per cent.

The average of 20 samples examined by the Halle (Germany) Experiment Station was 19.77 per cent of starch with a range from 17.72 to 22.78 per cent.

From the above comparisons it is evident that the potatoes which were sprayed were full higher in starch than most others which have been examined. If the per cent and a half more of starch found in the sprayed than in the unsprayed potatoes was due to the treatment of the vines, and no other explanation suggests itself, this alone is a strong argument in favor of spraying.

FERTILIZING MATERIALS REMOVED BY A CROP OF POTATOES.

Ash analyses of four samples of the potatoes are given on page 150. These results, calculated to the fresh potato, are given in the table which follows:

FERTILIZING CONSTITUENTS OF POTATOES CALCULATED TO WATER CONTENT OF FRESH POTATOES.

Variety.	Laboratory number.	Nitrogen.	Phosphoric acid.	Potash.	Lime.
		%	%	%	%
White Elephant	3045	.34	.12	.41	.01
White Elephant	3047	.33	.11	.43	.01
White Elephant	3050	.29	.15	.56	.01
White Elephant	3051	.28	.12	.52	.01
Average		.31	.13	.48	.01

* Experiment Station Record, Vol. 6, p. 410.

† Experiment Station Record, Vol. 5, p. 1017.

In the Year Book of the United States Department of Agriculture for 1896, are given figures which agree very closely with the above. These are compiled results and from the close agreement it would seem to indicate that the composition of potatoes, so far as nitrogen, phosphoric acid and potash are concerned, is fairly uniform.

Assuming these figures to fairly represent potatoes as grown in Maine, a crop of 200 bushels, weighing six tons, would remove thirty-seven pounds of nitrogen, sixteen pounds of phosphoric acid and fifty-eight pounds of potash.

If the amounts and proportions of fertilizing elements removed by a crop could be taken as a guide in preparing a field for that crop, the problem of supplying the proper amount and kind of plant food to the soil would be much simplified. To manure a field for a crop of potatoes, nitrogen, phosphoric acid and potash would have to be added in about the proportions given above and in sufficient quantity to supply the vines and tubers the land was expected to yield. A formula made up on this basis would be very materially different from any mixed fertilizer on the market and would contain the fertilizing elements in about the following proportions: Nitrogen, 5 parts; phosphoric acid, 2 parts; and potash, 8 parts. Twenty-six different brands of so-called potato fertilizers were sold in the State in 1899. The table which follows show how these goods were made up:

COMPOSITION OF SO-CALLED POTATO FERTILIZERS SOLD IN MAINE IN 1899.

	Nitrogen.	Available phosphoric acid.	Potash.
	%	%	%
12 brands	1.5—2.5	8—9	2—3.25
6 brands	2—2.5	6—9	4—6
8 brands	2.5—3.5	5.5—8	7—10

The first twelve brands mentioned cannot properly be called potato or special fertilizers as their composition is practically the same as all general purpose goods. The formulas of the last eight, approximate more nearly to the popular idea of what a

potato manure should be, but even these carry much more phosphoric acid in proportion to the nitrogen and potash they contain than is found in the plants or in farmyard manure.

It is possible that in using commercial fertilizers, more phosphoric acid is applied than is needed in many cases, yet there is not much evidence at hand in the form of accurate experimental data to prove this assertion. Many experiments have been made both in this country and Europe in growing potatoes with commercial fertilizers and chemicals, but very few experimenters have made a study of the relative proportions of the fertilizing elements that can be most profitably used.

L. Hecke* in his quite extensive experiments with chemicals on the potato plant found that it needed, throughout its entire period of growth, liberal supplies of all fertilizing elements. The demand for nitrogen was especially strong in the first half, and for potash in the last half of the season. The application of potash had a marked influence on the production of tubers and starch. Phosphoric acid had less effect, probably because the soil was quite rich in phosphates.

Experiments are reported by the New York Experiment Station,† in which the primary object was to determine the profitable amount of fertilizer to apply. Two formulas were used, one of which carried approximately nitrogen 4%, phosphoric acid 8.2%, potash 10%; the other, nitrogen 6.5%, phosphoric acid 4.8%, potash 10%. The quantities applied were the same for each formula, being 500, 1,000, 1,500 and 2,000 pounds per acre. One thousand pounds per acre of either kind yielded the largest profit, but the one carrying the most phosphoric acid gave the largest yields in every case; the greatest difference occurring when but 500 pounds were used, and least when 2,000 pounds were applied per acre. As the mixture high in phosphoric acid cost several dollars per ton less, on account of containing less nitrogen, it was more profitable than the other.

Experiments were made at the Kentucky Experiment Station‡ on a limestone soil quite rich in phosphoric acid, in growing potatoes with chemicals. The best yield was obtained when the three elements, nitrogen, phosphoric acid, and potash were used.

*Jour. Landw. 43 (1895) p. 285.
† Bulletin 137, 1897.
‡ Bulletin 55.

Much better crops were obtained when phosphoric acid and potash were used than when potash was used alone or with nitrogen only. The chemicals were added in the proportion of nitrogen 25.6 pounds, phosphoric acid 57 pounds and potash 80 pounds per acre, or if mixed, the composition would be nitrogen 5.5%, phosphoric acid 12.4%, potash 17%.

The Connecticut Experiment Station* made experiments to compare the effect of muriate with that of sulphate of potash on the starch content and yield of tubers. The potatoes were grown on very poor soil which was dressed with 400 pounds nitrate soda, 615 pounds acid phosphate and 120 pounds of muriate or sulphate of potash. The yield was increased from 43 to 228 bushels of salable tubers per acre. Doubling the potash, applying 240 pounds per acre, increased the yield only twelve bushels per acre over what was produced when 120 pounds were applied. Muriate produced a somewhat greater yield than sulphate, but the tubers contained slightly more water and less starch than when sulphate was used.

The evidence in regard to the relative effect of sulphate and muriate of potash on potatoes is somewhat conflicting. Most of the experiments made in this country and Europe show that sulphate produces better tubers with less water and a slightly higher starch content, but the difference is slight. Some German experimenters, Pfeiffer† and others, have recently published results of experiments showing that pure muriate has no injurious effect on the tubers, but impurities, noticeably chloride of magnesia, are influential in depressing the proportion of starch.

An analysis of the ash of the potato shows it to be exceedingly rich in potash, and the fact has led many to believe that a potato manure should contain a large amount of this element, but when we consider the small amount of ash a potato contains, we find the amount removed by an ordinary crop (58 pounds) is not greater than is taken up by any other farm crops. Two tons of mixed hay would take away sixty-three pounds, while two tons of red clover would take eighty-eight pounds of potash.

In preparing a field for any crop it is more essential to consider the special needs of the soil, to render it fertile, than the special

* Report 1895, p. 124.
† Die Land. Vers. Stat. Bd. 49, p. 49.

needs of the crop to be grown upon it. While it is true that some plants take up more of some one element than others, the difference is insignificant when compared with the difference in soils. The soils of Maine are extremely variable in character and composition and it is therefore impracticable to make a fertilizer formula for potatoes or any other crop that would be applicable in all cases. Each farmer who uses commercial fertilizers extensively should experiment with unmixed goods enough to determine to what elements his soil most readily and profitably responds. Some marl or limestone soils are quite rich in phosphoric acid and consequently a fertilizer containing a small amount of that element and relatively large amounts of nitrogen and potash would give best results, while some of our granite soils and clay loams are quite rich in potash and respond best to a fertilizer containing relatively large amount of phosphoric acid.

A study of the experimental data indicates that the potato plant thrives best in a rich soil which is abundantly supplied with all fertilizing elements. In the early stages of its growth, when the vines are forming, the demand for nitrogen is particularly large, and for this reason a potato fertilizer should contain quite a part of its nitrogen in a soluble, immediately available form. Later in the season, when the tubers are forming, large amounts of phosphoric acid and potash are required, also a bountiful supply of water to take up the plant food, etc., and transmit it through the vines.